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Title: Radiation Dispersal Devices A brief overview

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Radiation Dispersal Devices

A brief overview

These slides are UNCLASSIFIED

RDD Class Exercise

- What kind of material
- How much material is needed
  - Physically
- Where obtained
- How long to prepare
- Costs
- Who is needed to prepare
  - Any effects to them
- How will it be used
  - Where
  - How dispersed/deployed
- What will its effects be?

Have There Already Been RDD Attacks?

- **Harassment/Assault – many 10s**
- **Murder – perhaps 10**
- **Untargeted (but minor) – around 5**

Bio. vs. Chem. vs Rad.

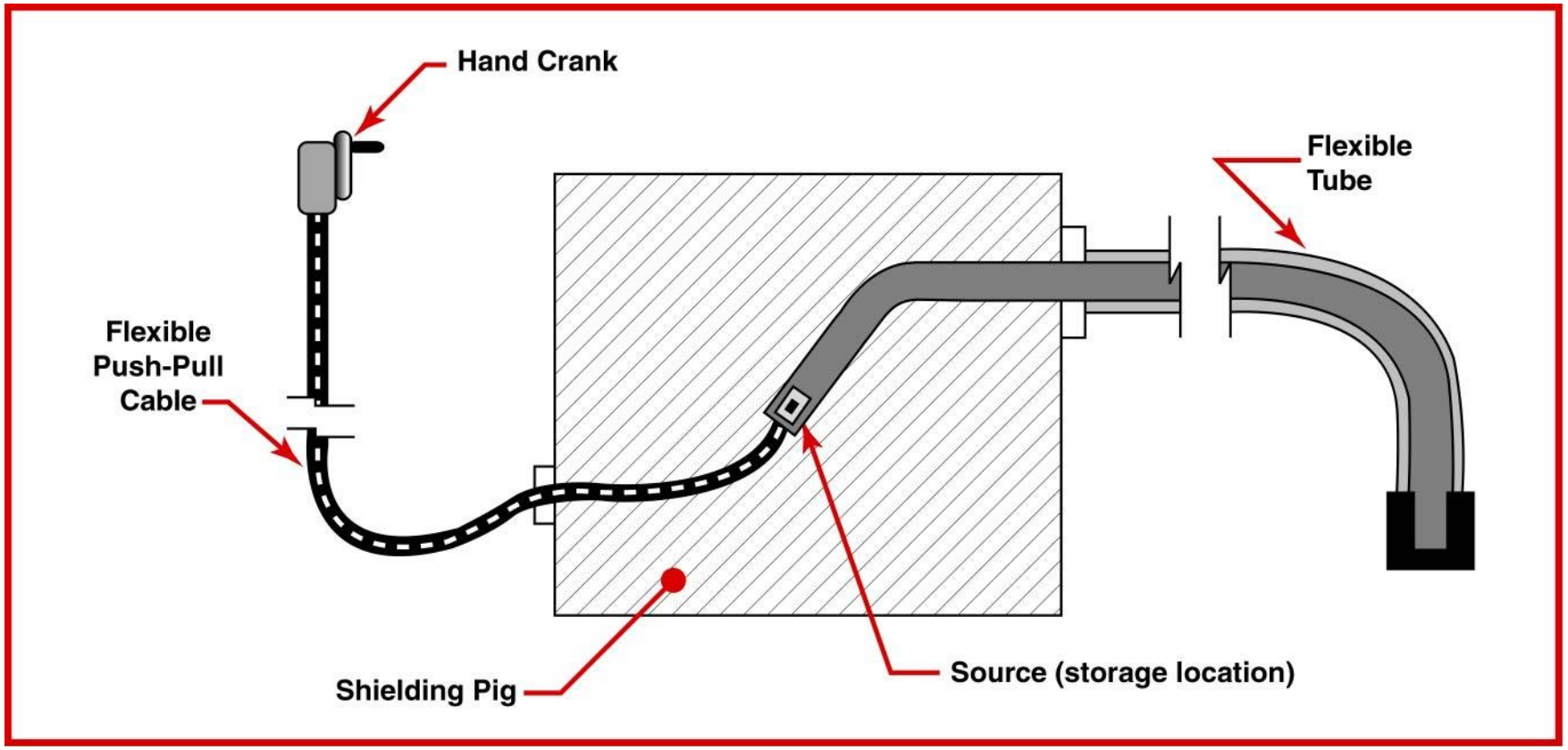
Anthrax	Sarin	Cesium-137
Fall 2001 US East Coast	3/20/95 Tokyo Subway	9/13/87 Goiania, Brazil
5 letters ~2 grams/envelope $2x10^{12}$ spores/envelope	~7 kg total ~4.5 kg released	1375 Ci 16 grams
$2x10^{8}$ Lethal Doses	**$4x10^{6}$ Lethal Doses**	**10^{5} Lethal Doses**
5 deaths ~24 ill ~10^{4} rec'd antibiotics	10 deaths ~37 moderately ill 5510 sought care	4 deaths 20 hospitalized 112,000 monitored

Anthropogenic Radiation Sources

Radiographic and Other Industrial Sources

- **Cobalt-60 – gamma; metal**
- **Cesium-137 – gamma; soluble compound, ceramic**
- **Iridium-192 – gamma; metal**
- **Radium (Radon) – gamma; soluble compound**
- **Strontium-90/Yttrium-90 – beta; insoluble or soluble compound**

Schematic of a Typical Source Storage/Deployment Arrangement



Industrial Irradiator

Curie Content and Exposure Tunnel

IRRADIATOR	CURIE CONTENT	MAX. DOSE RATE	MIN. DOSE RATE
High Dose	19,200 Co_{60}	10^7 R/Hr 145 krad(SiO_2)/min	200 R/Hr 2.9 rad(SiO_2)/min
Low Dose	100 Co_{60}	$6x10^3$ R/Hr 87 rad(SiO_2)/min	100 R/Hr 1.45 rad(SiO_2)/min
Low Dose	130 Cs_{137}	$6x10^3$ R/Hr 87 rad(SiO_2)/min	100 R/Hr 1.45 rad(SiO_2)/min

Cesium and Cobalt irradiators are used in a variety of industrial and research applications, primarily for sterilization. Typically, these units can contain significant quantities of radioisotopes in a sealed source form.

Portable Nuclear Gages

Model 3440

Model 3430

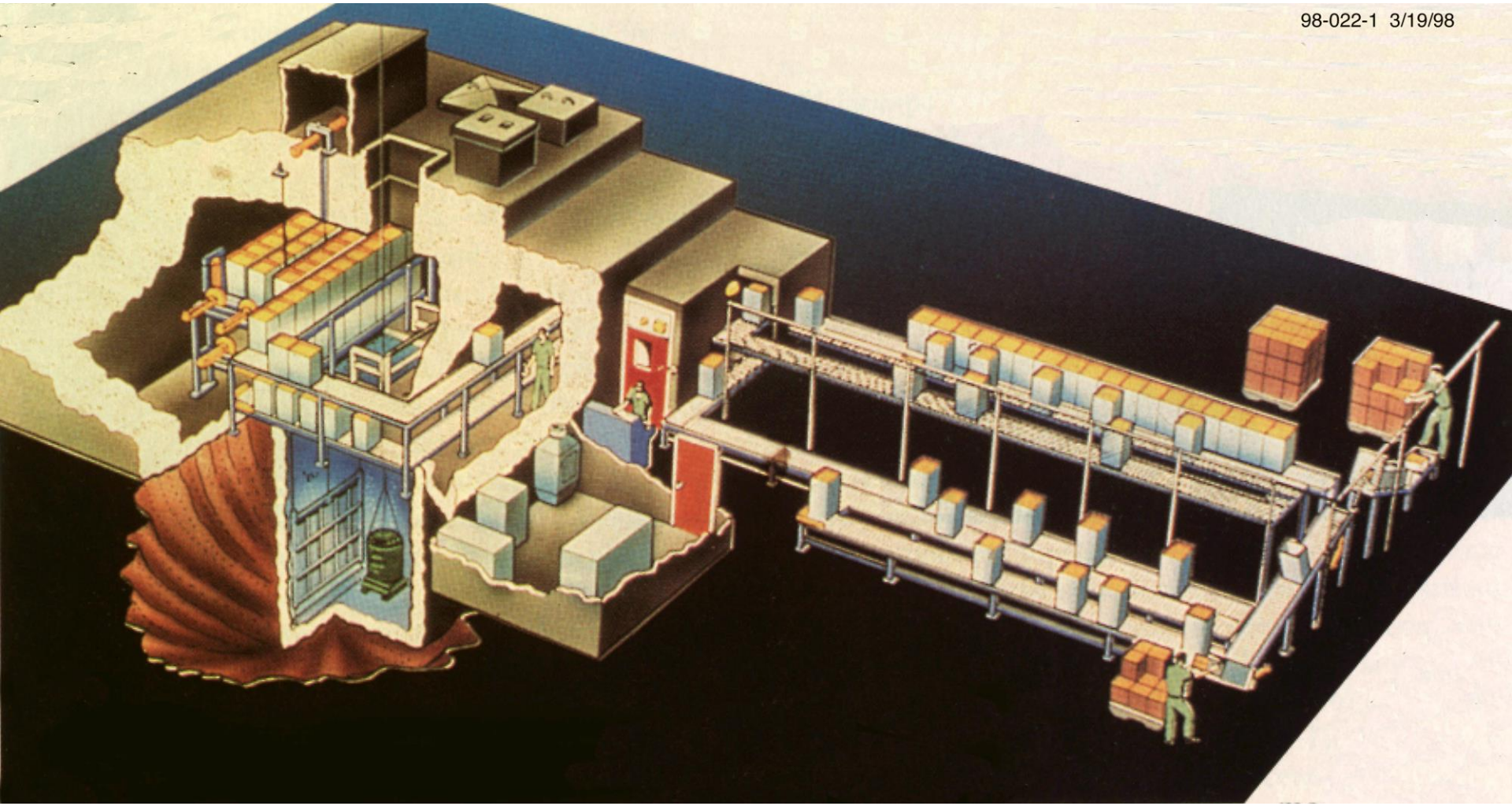
Moisture/density gages used in construction are one of the most common nuclear sealed source applications. Tens of thousands of such units have been distributed world wide. Typically each gage contains one 10-20 mCi Cesium source and one 40-100 mCi Americium/Beryllium neutron source.

Blood Irradiators

Irradiation of blood & blood products by gamma rays is a proven and safe method to inhibit T-Lymphocyte Proliferation and eliminate the risk of post transfusion graft versus host disease (T-GVHD). Blood is usually irradiated in standard blood bags in dedicated blood irradiators using Cobalt-60 or Cesium-137 radioactive source. Typically blood irradiators use a number of individual sources containing around 100 Curies each of Cesium or Cobalt. The usual recommended radiation doses are 25 Gy to 35 Gy (1 Gy = 100 rad) for this purposes.

Radiosterilization Facility

MCi of Co-60 or Cs-137



Radioisotopic Thermoelectric Generators (RTG)

- **Applications: Remote Power**
  - **Internal, Space, Deep Oceans, Terrestrial**
  - **For example: pacemakers, remote Russian lighthouses, remote Alaskan seismometers**
- **Sr-90 (β-emitter) & Pu-238 (α-emitter) used**
  - **Sr-90: $t_{1/2}$ = 28.8 yr, strong bone seeker (Y-90)**
  - **Pu-238: $t_{1/2}$ = 87.7 yr, serious inhalation hazard**

- **Russian Sr-90 RTGs: 50 kCi (1,850 TBq) - 18 We**
  260 kCi (9,620 TBq) - 130 We

- **U.S. Sr-90 RTGs: 107 kCi (3,960 TBq) - 31 We**
  328 kCi (12,136 TBq) - 98 We

Russian Sr-90 RTGs

Decayed but Still Radioactive Heat Sources are Carefully Disposed Of

RTG sources found in Georgia

Irradiated (Spent) Reactor Fuel

- **Enormous Range of Materials/Configurations**
  - **Huge (4 m, 660 kg) sintered LEU oxide clad w/ Zirconium alloy**
  - **Handy (0.6 m, 0.3 kg) HEU alloy clad w/ Aluminum**
  - **Everything in between**

- **Enormous Range of Radioactivity, from Fresh to:**
  - **At-discharge LWR = 9×10^8 Rem/hr**
  - **5y Since-discharge LWR = 1.6×10^3 Rem/hr**
  - **20y Since-discharge LWR = 100 Rem/hr**

Weird Science

Malevolent Use

Source Dispersal Techniques

- **Explosives**
- **Fire**
- **Aerodynamic**
- **Solution**
- **Passive**

Explosive Dispersal

- **Results uncertain**
  - **HE – Source coupling**
  - **Surrounding material**
- **Dispersal reduces hazard**
- **Detonations draw attention**
- **Easy**

Effect of Dispersal
(adapted from LLNL study)

Fixed Placement Example:

A bare 10 Ci Cobalt-60 source in a fixed location gives a dose of about 150 rem/hr to people one foot away.

Walking by slowly gives a dose of about 85 mrem.

Dispersed Placement Example:

10 Ci of Cobalt-60 spread uniformly over one square kilometer would give people in this area a dose of about 0.4 mrem/hr.

Walking through gives a dose of approx. 0.06 mrem

Passive (non-) Dispersal

- **Maximizes hazard**
- **Can minimize response**
- **Targets a specific group**

Psychological Scenario

- **Minimal threat, public fear high**
- **Response driven by public perceptions and fears, not science**
- **Rogue rad measurements and/or interpretations may exacerbate concern**
- **Threats are common, must overcome the publication barrier**

Large Sources Bring Operational Problems

- **Personnel Hazard**
  - **Disability in few minutes to hours**
- **Detectability**
- **Heat**
- **Damage to Electronics**
- **OPSEC**